1 Water is stored in a reservoir at an average vertical height of 350 m above the turbines of a hydroelectric power station.

During a 7.0 hour period, $1.8 \times 10^6\,m^3$ of water flows down from the reservoir to the turbines.

(a) The density of water is $1000\,kg/m^3$.

For this 7.0 hour period, calculate

(i) the mass of water that flows from the reservoir to the turbines,

mass = ... [2]

(ii) the gravitational potential energy transformed as the water flows to the turbines,

energy = ... [2]

(iii) the maximum possible average output power.

power = ... [2]

(b) A hydroelectric power station generates electricity from a renewable energy source.

(i) Explain what is meant, in this context, by *renewable*.

....

.... [1]

(ii) State two other renewable energy sources.

1. ....

2. ....

[2]

[Total: 9]

MARKING SCHEME:

(a)	**(i)**	(m =) ρV OR $1000 \times 1.8 \times 10^6$	C1	
		1.8×10^9 kg	A1	
	(ii)	(g.p.e. =)mgh OR $1.8 \times 10^9 \times 10 \times 350$ (e.c.f. from **(a)(i)**)	C1	
		6.3×10^{12} J (e.c.f. from **(a)(i)**)	A1	
	(iii)	(P =)E/t OR $6.3 \times 10^{12}/7$ OR $6.3 \times 10^{12}/(7 \times 60)$ OR $6.3 \times 10^{12}/(7 \times 3600)$ (ecf from **(a)(i)(ii)**)	C1	
		2.5×10^8 W (e.c.f. from **(a)(i)(ii)**)	A1	
(b)	**(i)**	continuously regenerated / not used up / everlasting supply IGNORE used again / recycled / can be renewed	B1	
	(ii)	any **two** of: biomass/geothermal/solar/ tidal/wave/wind energy/wood (NOT nuclear/light)	B2	[9]

2 **(a)** On a day with no wind, a fountain in Switzerland propels 30 000 kg of water per minute to a height of 140 m.

Calculate the power used in raising the water.

power = ... [4]

(b) The efficiency of the pump which operates the fountain is 70%.

Calculate the power supplied to the pump.

power = ... [3]

(c) On another day, a horizontal wind is blowing. The water does not rise vertically.

Explain why the water still rises to a height of 140 m.

....

.... [1]

[Total: 8]

MARKING SCHEME:

(a)	*Fd* OR weight × *d* OR *mgh* OR 30 000 × 10 × 140 OR 4.2×10^7 seen anywhere	C1
	(*P* =) *E* / *t* OR *W* / *t* OR *mgh* / *t* symbols or words	C1
	$4.2 \times 10^7 / 60$	C1
	7.0×10^5 W / 700 kW / 0.7 MW	A1
(b)	efficiency = output / input OR (P_{in} =) 100 × P_{out} / efficiency	C1
	(P_{in} =) $100 \times 7 \times 10^5 / 70$	C1
	1.0×10^6 W OR 1 000 000 W OR 1.0 MW	A1
(c)	(horizontal) wind has no effect on P.E gained / vertical force on water OR same upward / vertical force acts on water OR force from wind is horizontal	B1

[Total: 8]

3 A farmer uses an electric pump to raise water from a river in order to fill the irrigation channels that keep the soil in his fields moist.

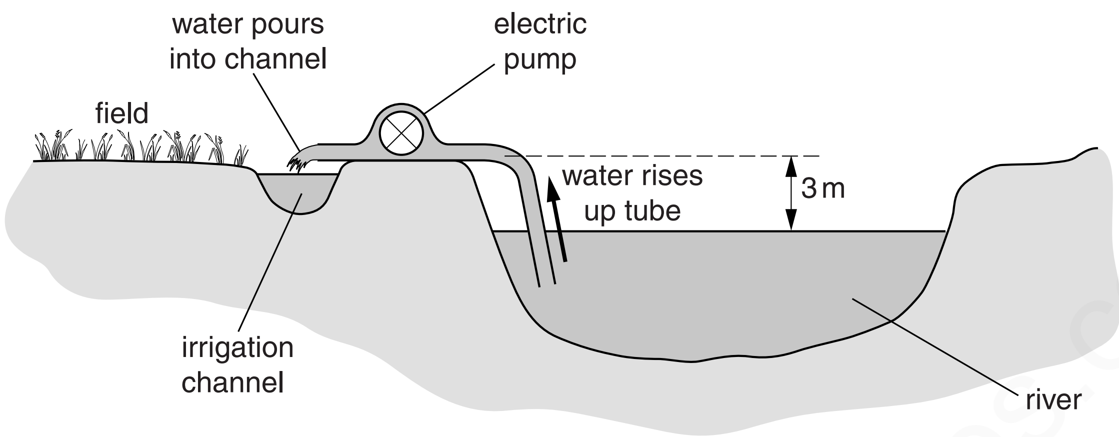

Fig. 5.1

Every minute, the pump raises 12 kg of water through a vertical height of 3 m.

(a) Calculate the increase in the gravitational potential energy of 12 kg of water when it is raised 3 m.

increase in gravitational potential energy = ... [3]

(b) Calculate the useful power output of the pump as it raises the water.

power = ... [3]

[Total: 6]

MARKING SCHEME:

(a)	(P.E.) = mgh		C1
	12 × 10 × 3	Accept g = 9.8 or 9.81	C1
	360 J	g = 9.8 gives 352.8 J (minimum 2 s.f.) g = 9.81 gives 353.16 J (minimum 2 s.f.)	A1
(b)	(P =) E/t		C1
	360/60		C1
	6 W	352.8 J gives 5.88 W 353.16 J gives 5.886 W (minimum 2 s.f.)	A1

[6]

4 Fig. 5.1 shows a model cable-car system. It is driven by an electric motor coupled to a gear system.

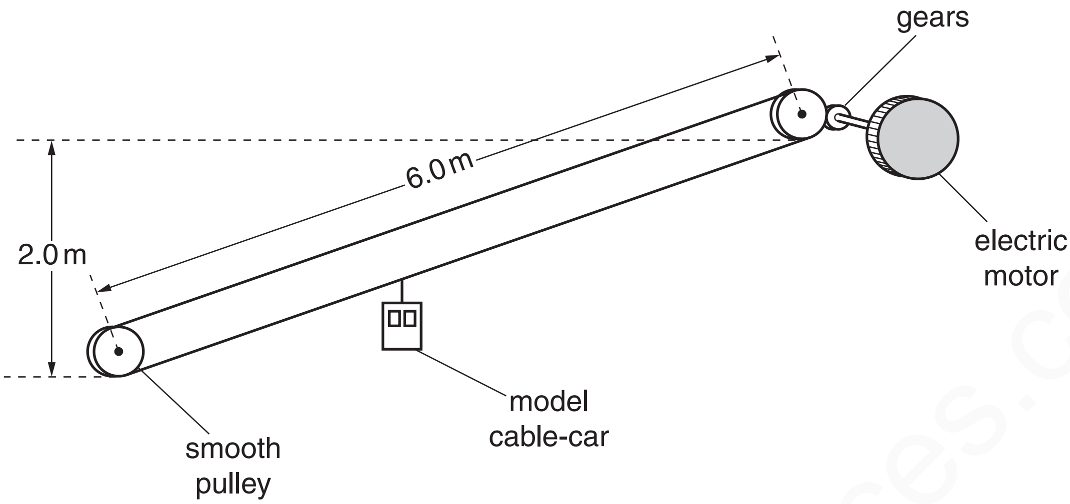

Fig. 5.1

The model cable-car has a mass of 5.0 kg and is lifted from the bottom pulley to the top pulley in 40 s. It stops automatically at the top.

(a) Calculate

(i) the average speed of the cable-car,

average speed = ... [2]

(ii) the gravitational potential energy gained by the cable-car,

gravitational potential energy gained = ... [2]

(iii) the useful output power of the driving mechanism.

power = ... [2]

(b) How would the electrical power input to the motor compare with your answer to **(a)(iii)**?

.... [1]

[Total: 7]

MARKING SCHEME:

(a)	**(i)**	(speed =) distance/time in any form, words, letters, numbers	C1
		0.15 m/s or 15 cm/s	A1
		(if answer only, 1 mark for either if no units)	
	(ii)	(PE =) mgh OR mgh OR Wh symbols, words or numbers	C1
		100 J OR 98.1 J OR 98 J	A1
	(iii)	his **(ii)**/40 OR his **(ii)**/4	C1
		2.5 W OR 2.45 W e.c.f. from **(ii)**	A1
(b)		(input) greater/output less NOT a numerical factor	B1

[Total: 7]

5 A boy drops a ball of mass 0.50 kg. The ball falls a distance of 1.1 m, as shown in Fig. 6.1. Ignore air resistance throughout this question.

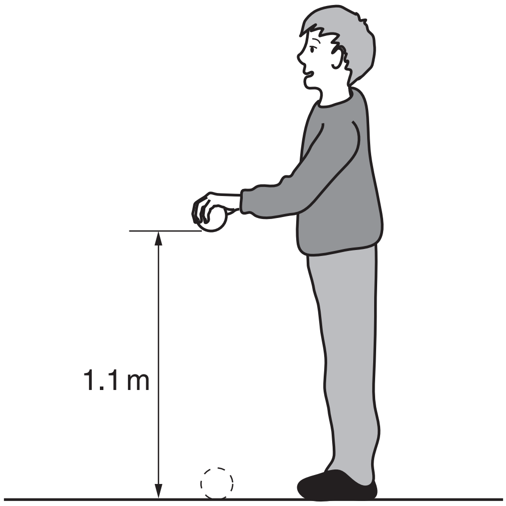

Fig. 6.1

(a) Calculate the decrease in gravitational potential energy of the ball as it falls through the 1.1 m.

decrease in potential energy = ... [2]

(b) The ball bounces and only rises to a height of 0.80 m.

(i) Calculate the energy lost during the bounce.

energy lost = ... [1]

(ii) Suggest one reason why energy is lost during the bounce.

....

.... [1]

(c) On another occasion, the boy **throws** the ball down from a height of 1.1 m, giving it an initial kinetic energy of 9.0 J.

Calculate the speed at which the ball hits the ground.

speed = ... [3]

[Total: 7]

MARKING SCHEME:

(a)	*mgh* OR 0.5 × 10 × 1.1	C1
	5.5 J	A1
(b)	**(i)** 1.5 (J)	B1
	(ii) energy used to deform ball/ground OR strain energy stored in (deformed) ball/ground OR heat generated in deformed ball/ground	B1
(c)	(initial energy =) 9 + answer to **(a)**, correctly evaluated	C1
	use of $\frac{1}{2}mv^2$	C1
	7.6 m/s	B1

[Total: 7]

6 **(a)** Energy from the Sun evaporates water from the sea. Some of this water eventually drives a hydroelectric power station. Give an account of the processes and energy changes involved.

....

....

....

....

....

....

....

....

....

....[4]

(b) In a hydroelectric power station, 200 000 kg of water per second fall through a vertical distance of 120 m. The water passes through turbines to generate electricity, and leaves the turbines with a speed of 14 m/s.

(i) Calculate the gravitational potential energy lost by the water in 1 second. Use $g = 10\,\text{m/s}^2$.

potential energy lost = ...[2]

(ii) Calculate the kinetic energy of the water leaving the turbines in 1 second.

kinetic energy = ...[2]

[Total: 8]

MARKING SCHEME:

(a) two processes from:
vapour rising
condensation
rain falling
water falling from lake / through pipes
water turns turbine / generator
electricity generated. max B2

energy changes:
PE to KE matched to a process B1
KE to electricity energy for turbine / power station B1

(b) **(i)** (PE =) mgh OR $2 \times 10^5 \times 10 \times 120$ allow g = 9.8 or 9.81 C1
2.4×10^8 J A1

(ii) (KE of water =) $\frac{1}{2}mv^2$ OR $\frac{1}{2} \times 2 \times 10^5 \times 14^2$ C1
1.96×10^7 J OR 2.0×10^7 J A1 [8]